РОСКОСМОС

РЕШЕТНЕВ
ОАО «ИСС»

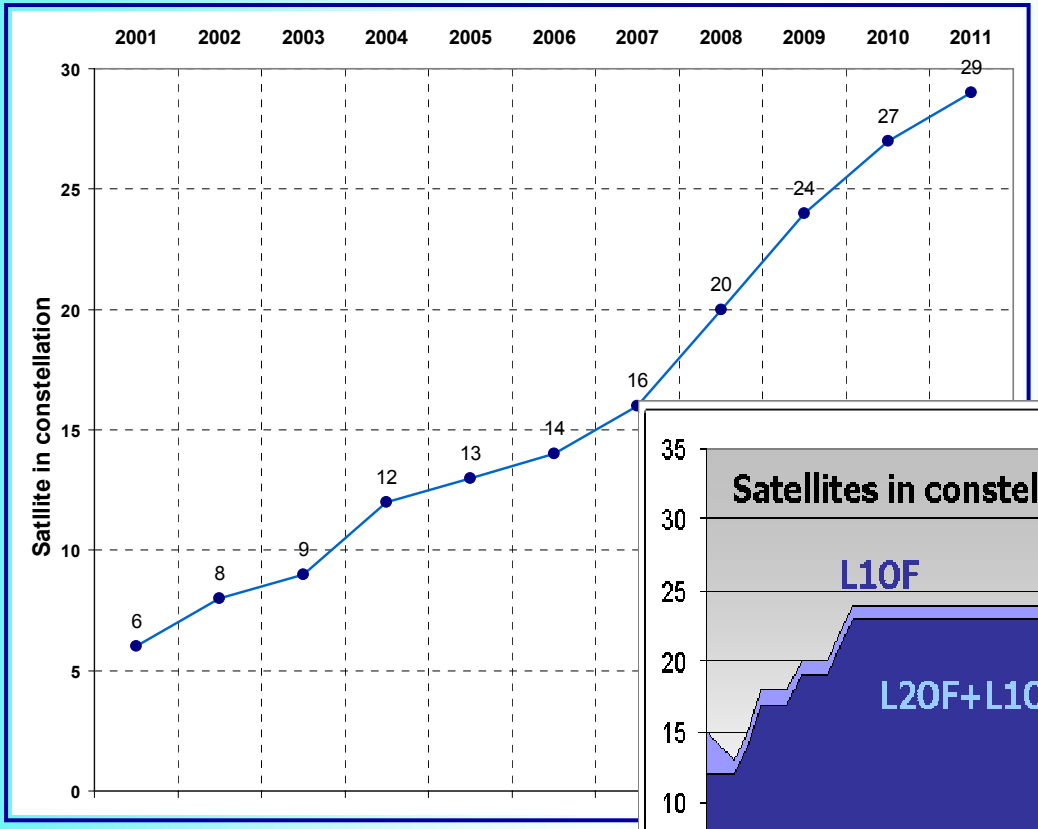
Satellite system GLONASS Status and Plans

Information Satellite System - Reshetnev Company

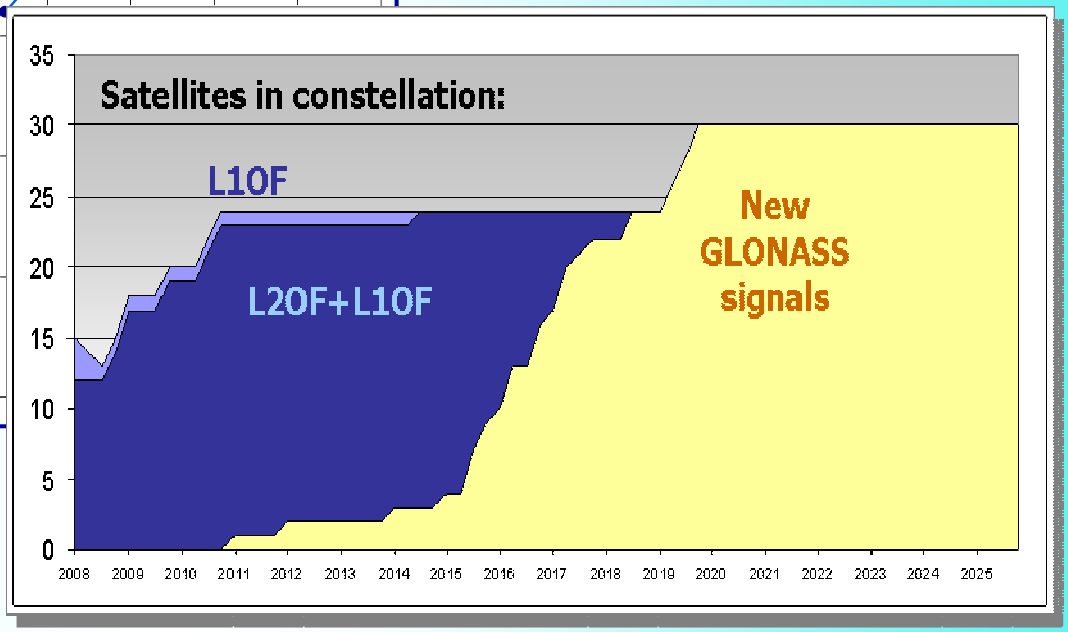
Overview

- GLONASS constellation status
- GLONASS coverage and availability
- GLONASS accuracy
- GLONASS constellation and signal modernization
- Ground Control Segment Modernization

GLONASS constellation deployment



- L1OF+ L2OF transmits by 18 Glonass-M sats
- Only L1OF transmits by 1 old Glonass and 1 Glonass-M sats



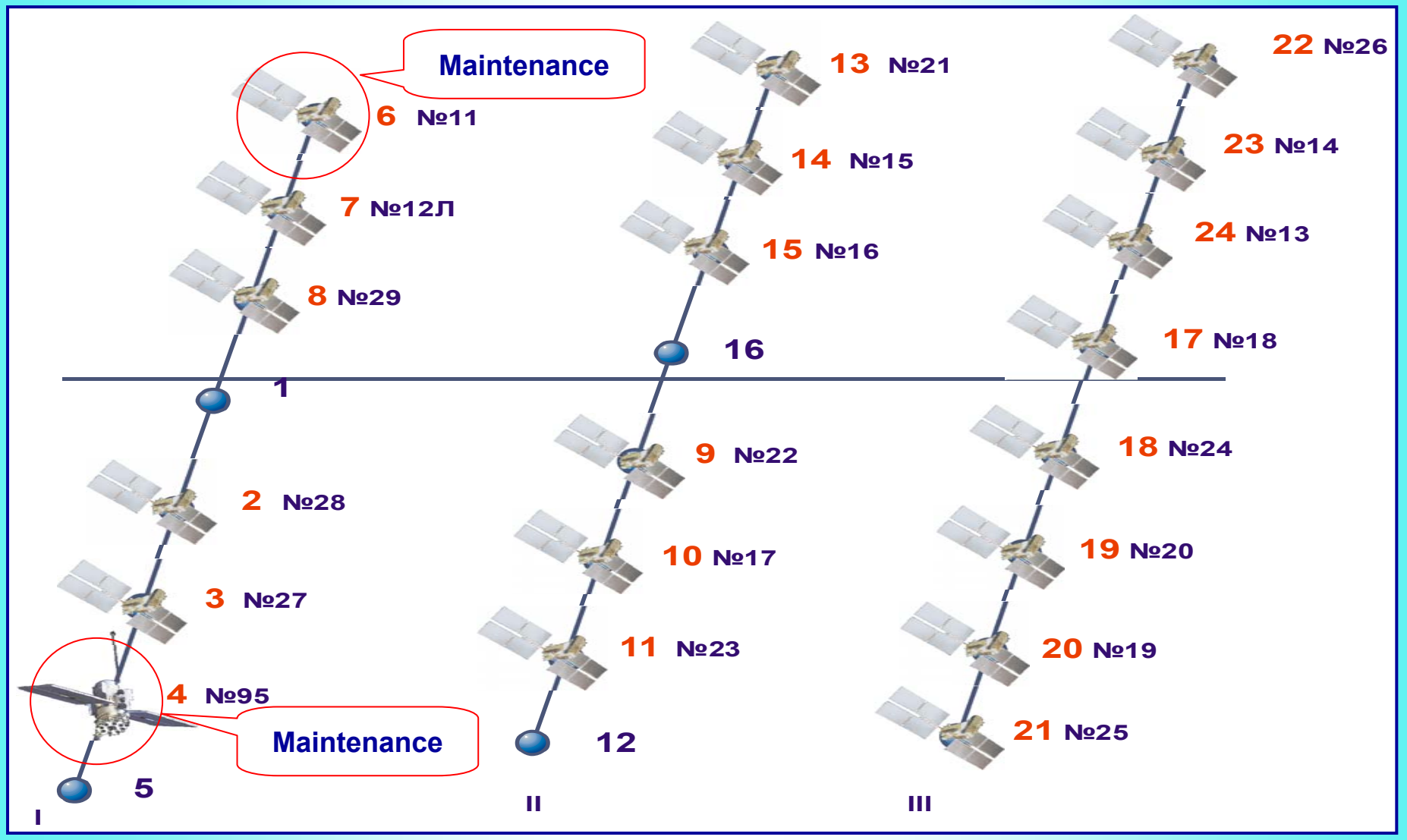
- 18 Glonass-M satellites available for double frequency measurements

Constellation Update based on GLONASS-K

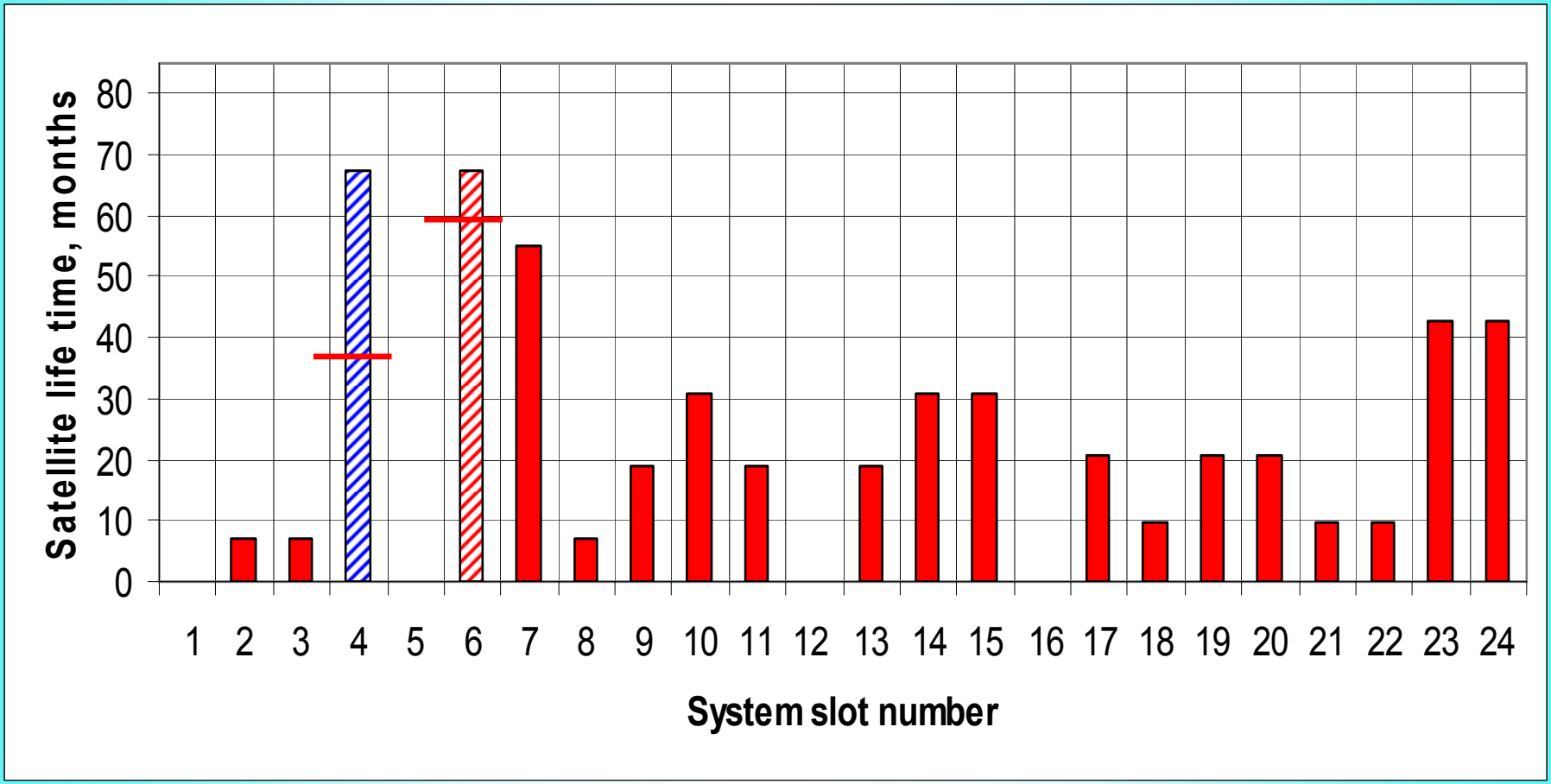
GLONASS-K Flight Tests

GLONASS Constellation Status

23 July 2009



GLONASS satellite age



NavSat “Glonass” - guaranteed life time 3 years (36m)

NavSat “Glonass-M” - guaranteed life time 7 years (84m)

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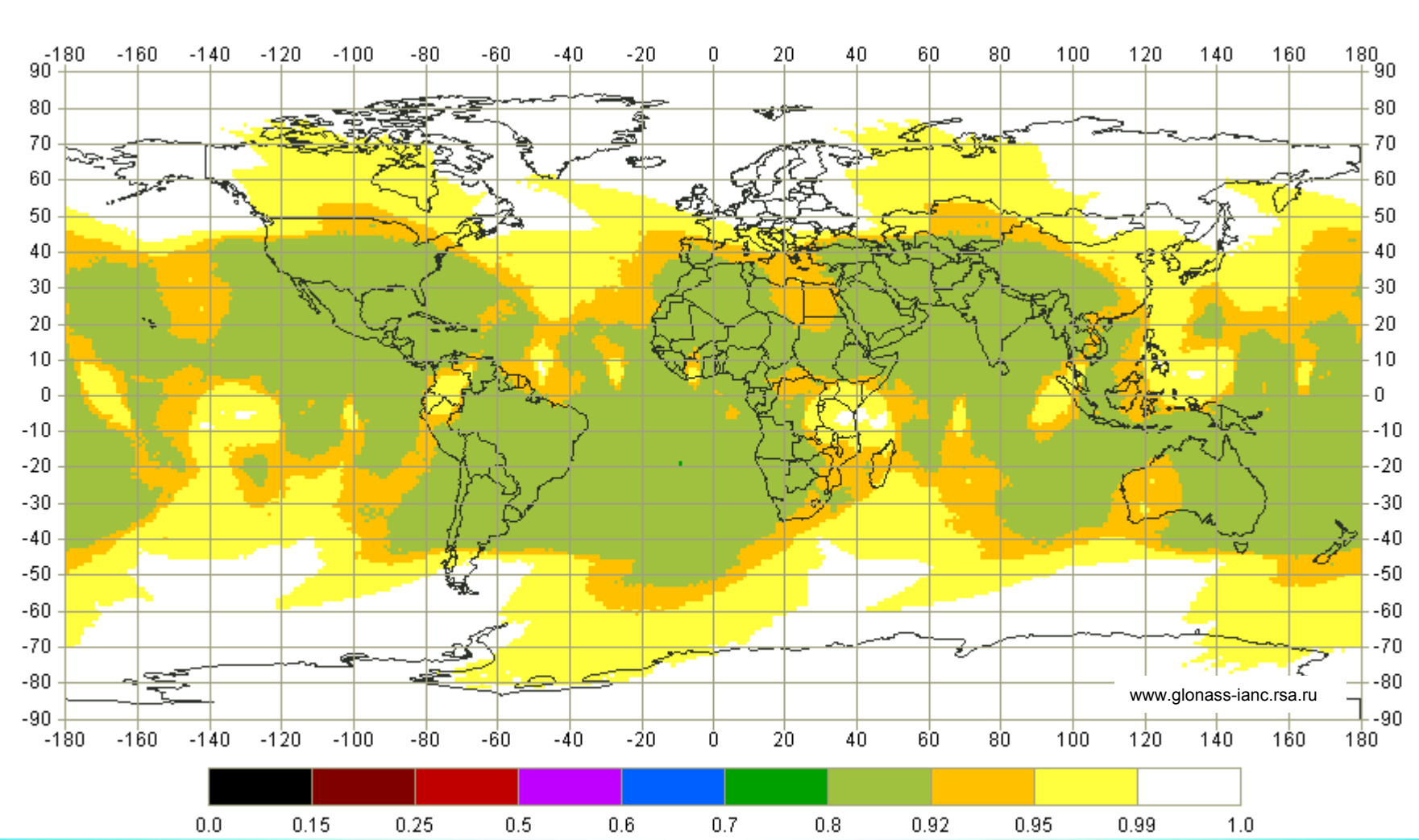
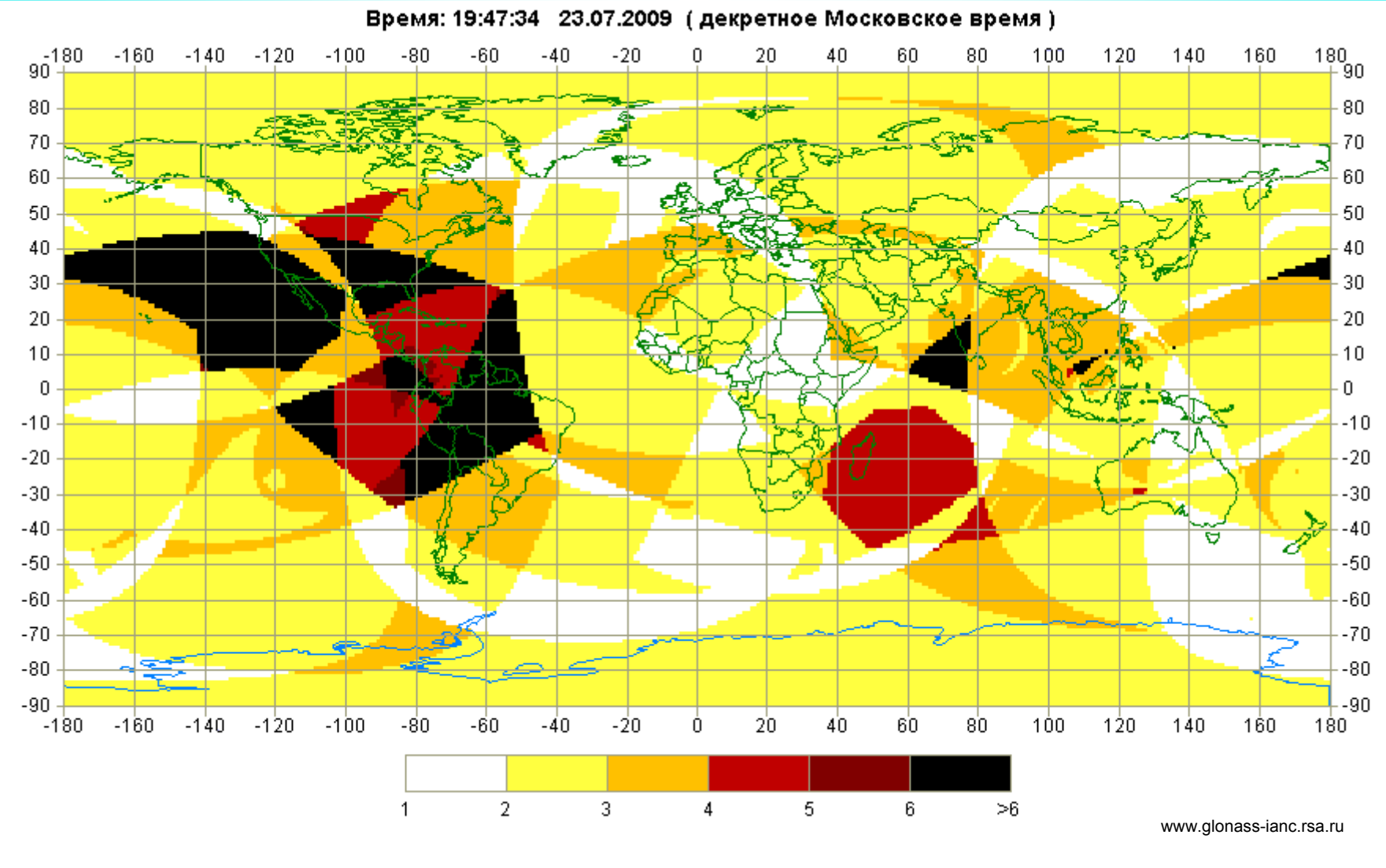
GLONASS availability

(PDOP<=6),elevation mask 5°.For 23.07.2009. 18 health satellites (20 satellite in system)



Current GLONASS PDOP global coverage

(18 health satellite in constellation)



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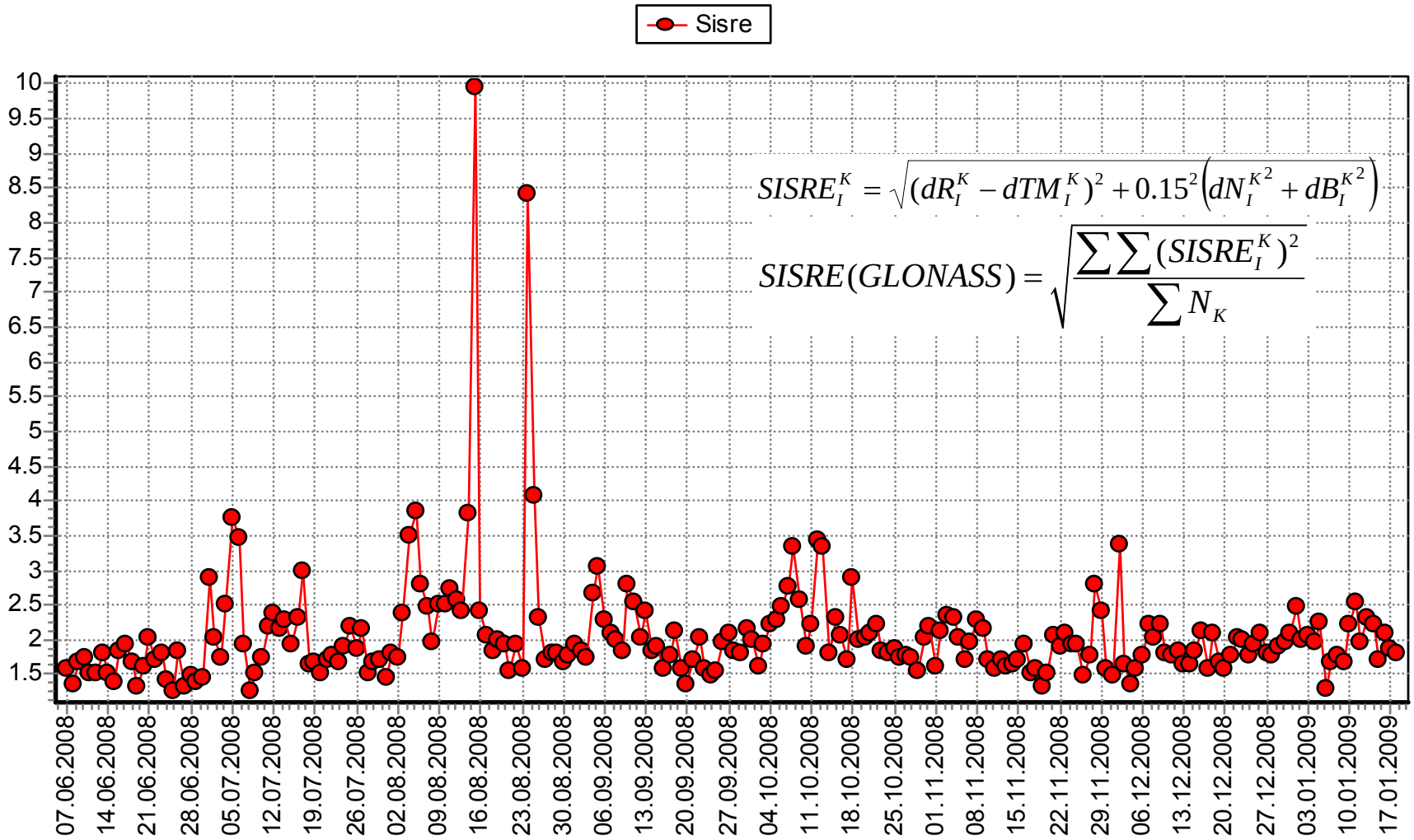
System pseudorange accuracy SISRE for Glonass-M satellites

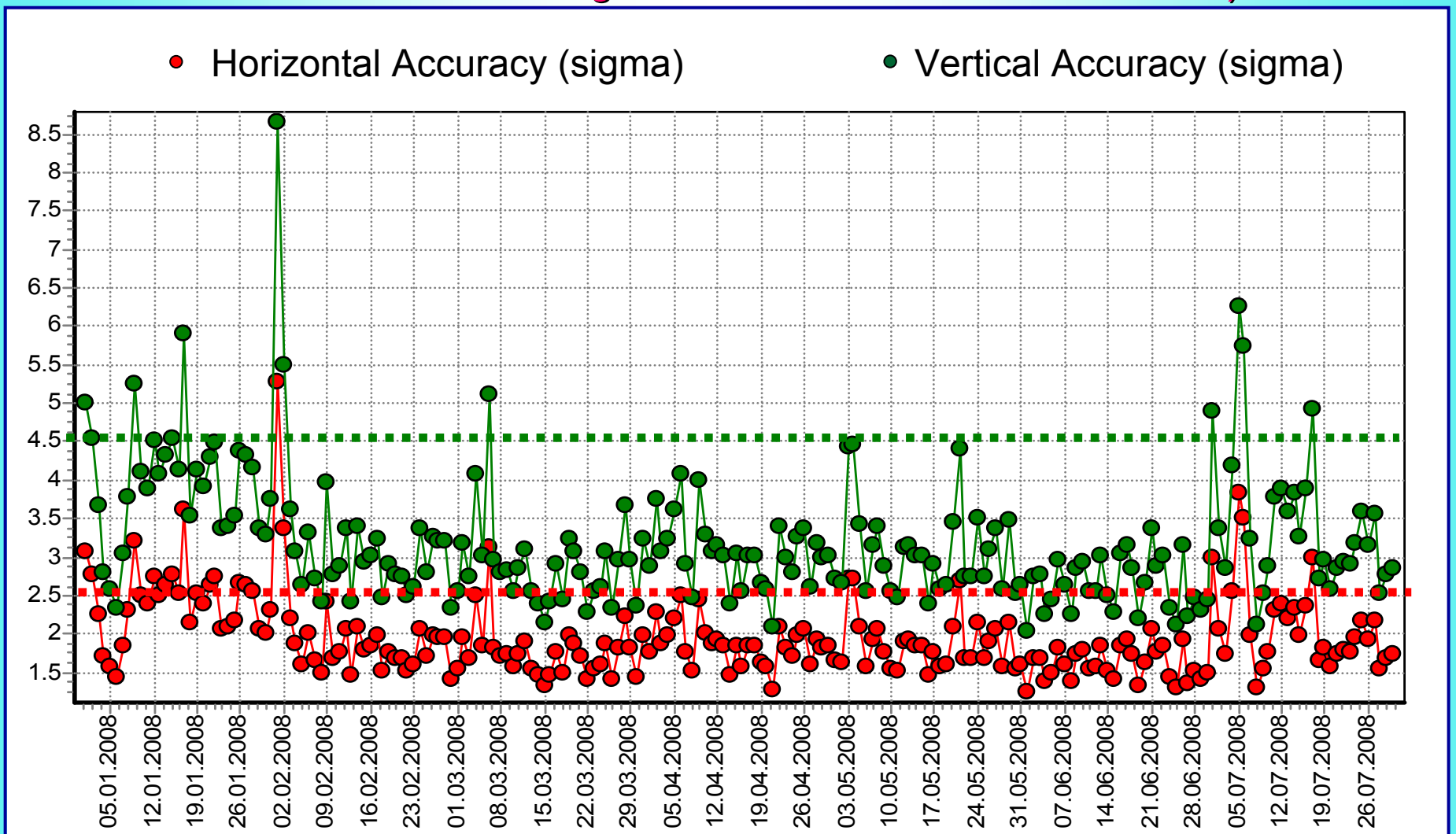


$$SISRE_I^K = \sqrt{(dR_I^K - dTM_I^K)^2 + 0.15^2\left(dN_I^{K\,2} + dB_I^{K\,2}\right)}$$

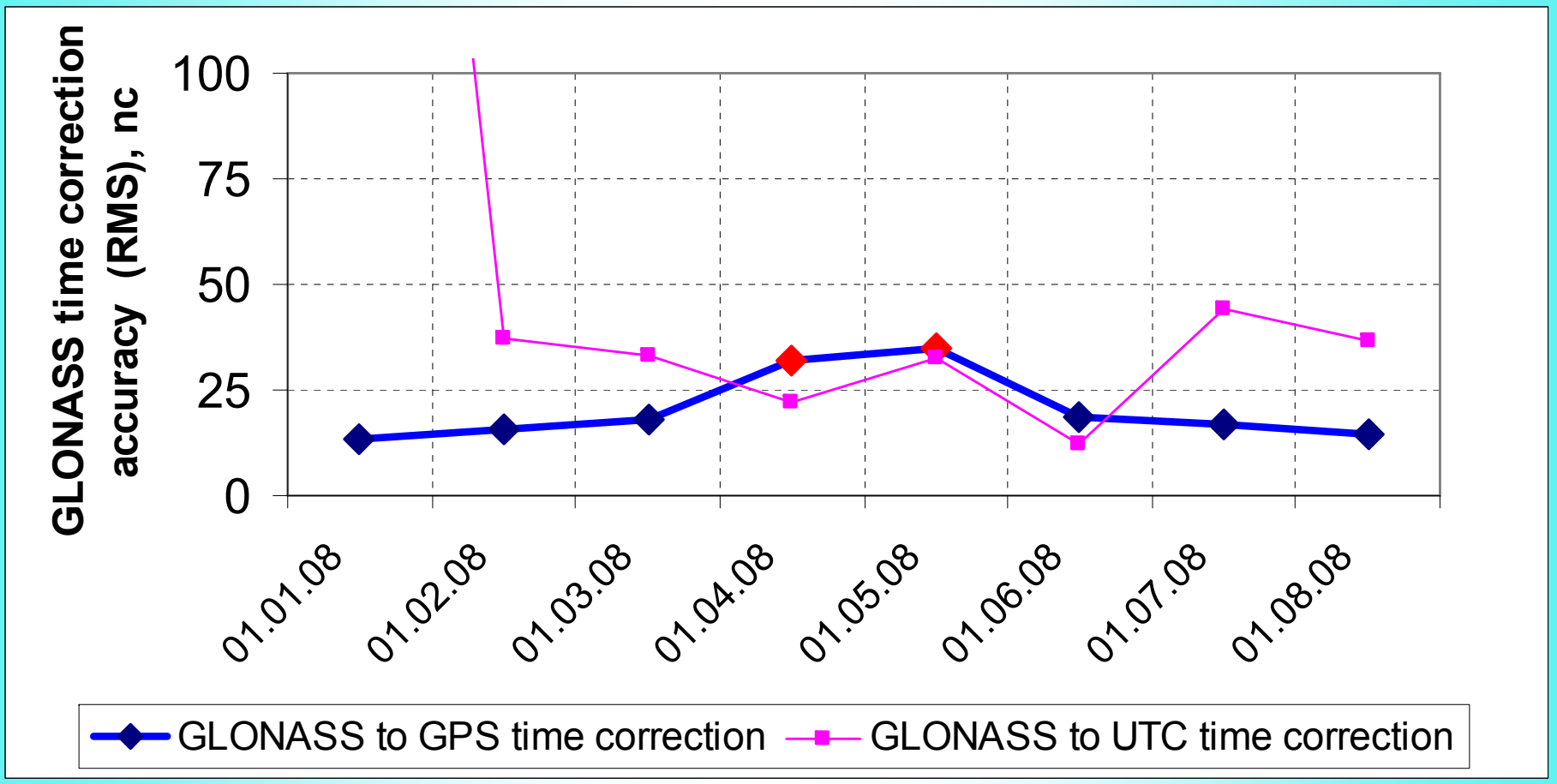
$$SISRE(GLONASS) = \sqrt{\frac{\sum\sum (SISRE_I^K)^2}{\sum N_K}}$$

GLONASS positioning accuracy

(RMS value from 01.01.08 to 01.08.08 by real SISRE Glonass-M monitoring data and 24 sat. in constellation)



GLONASS TIME



GLONASS-M performance standard accuracy

	Globall average	In worst place
Horizontal Accuracy (95%)	5 m	12 m
Vertical Accuracy (95%)	9 m	25 m
UTC time correction error, not more than	700 nc	700 nc

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The main directions of GLONASS development

- Full deployment and modernizations of GLONASS orbit constellation with orbital spare
- Increasing of system availability performance
- Increasing of navigating field accuracy performances
- Increasing of system integrity performances
- Modernization of navigating signals

Evolution of GLONASS satellite

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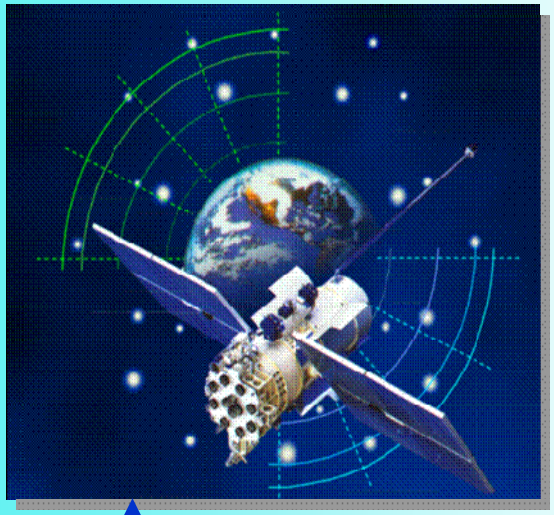
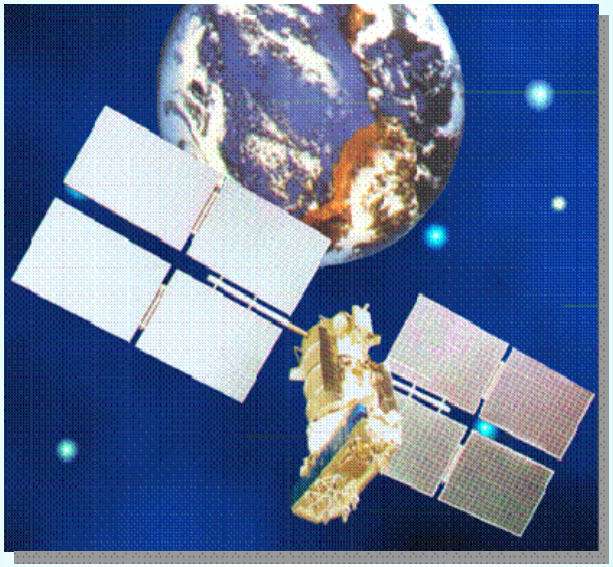
РЕШЕТНЕВ

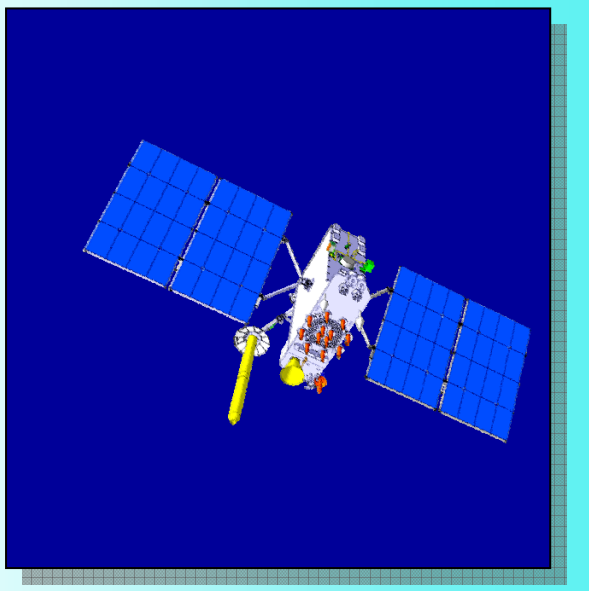
«Glonass»



«Glonass-M»



«Glonass-K»



1982 2003 2010

Navigation satellite “Glonass-M”

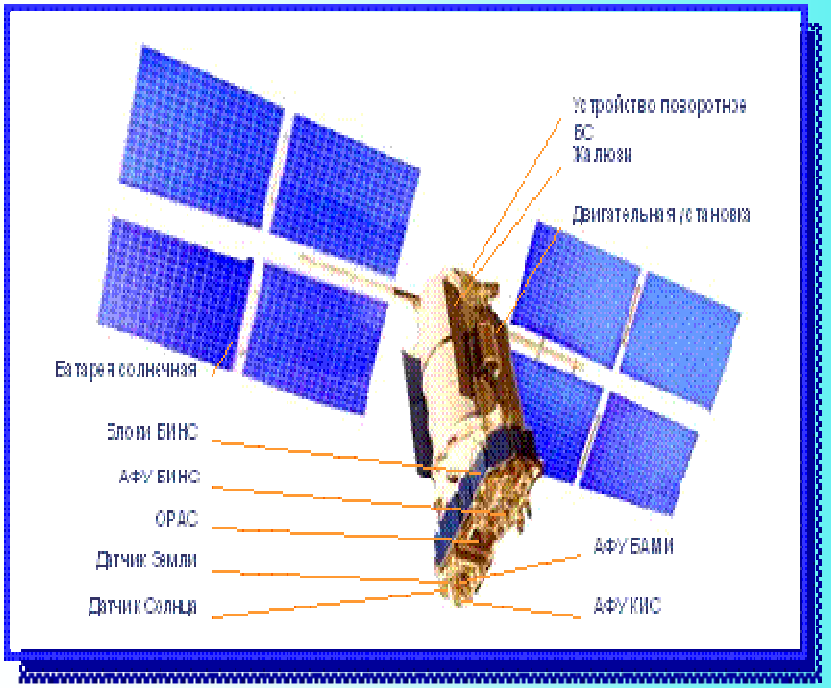
Main features

- Guaranteed life time 7 years;
- Mass 1415 kg;
- Clock stability 1e-13;
- Attitude control accuracy 0,5 deg;
- Level of unpropogated forces 5e-11 m/c²
- Navigations signals:

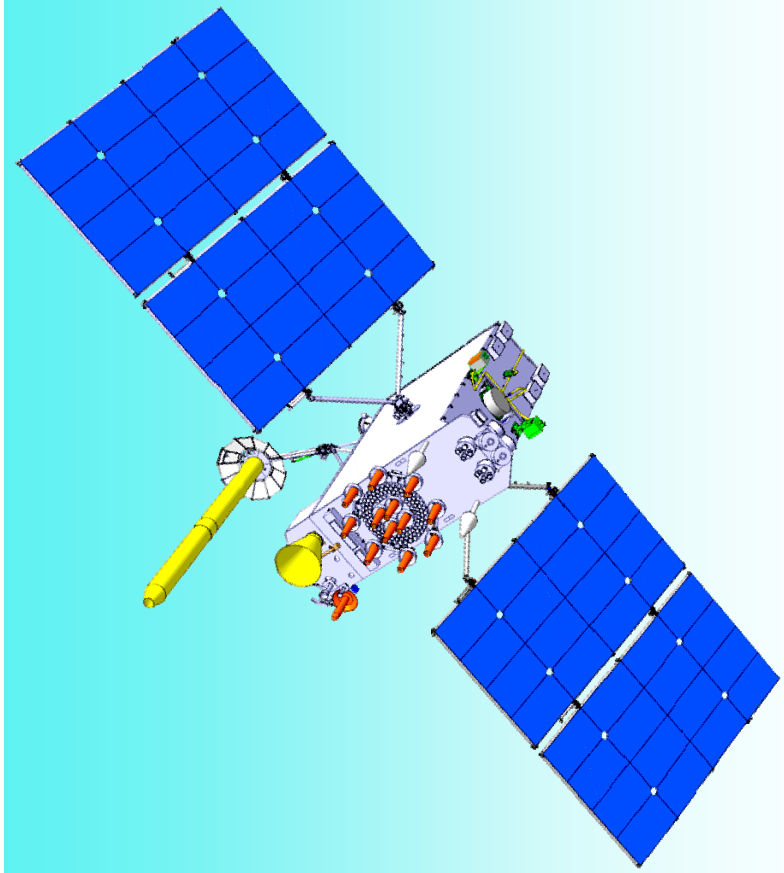
4 signals in L1 and L2 bands with FDMA

Main features

- Extended life time
- Second civil signal L2
- Increased board clock stability
- Improved attitude and the solar panel pointing accuracy
- Improved dynamic model
- Using Inter Satellite Link (ISL) measurements for improvement ephemeris and clock navigation data



Navigation satellite “Glonass-K”



Main features

Guaranteed life time	10 years;
Mass	995 kg;
Clock stability	1e-14;
Level of unpropogated forces	1e-11 m/c2

Navigations signals:
Four FDMA signals in L1 and L2 bands
New CDMA signals in L1, L2, L3 bands

Main features

- Extended life time;
- New CDMA navigating signals
- Improved attitude and the solar panel pointing accuracy
- Dramatically decreasing level of the unpropogated not gravity forces;
- Provides the high precision thermal control for onboard clock (0,1 ° - 0,5 ° C);
- Additional suffering disaster payload (Cospas-Sarsat)

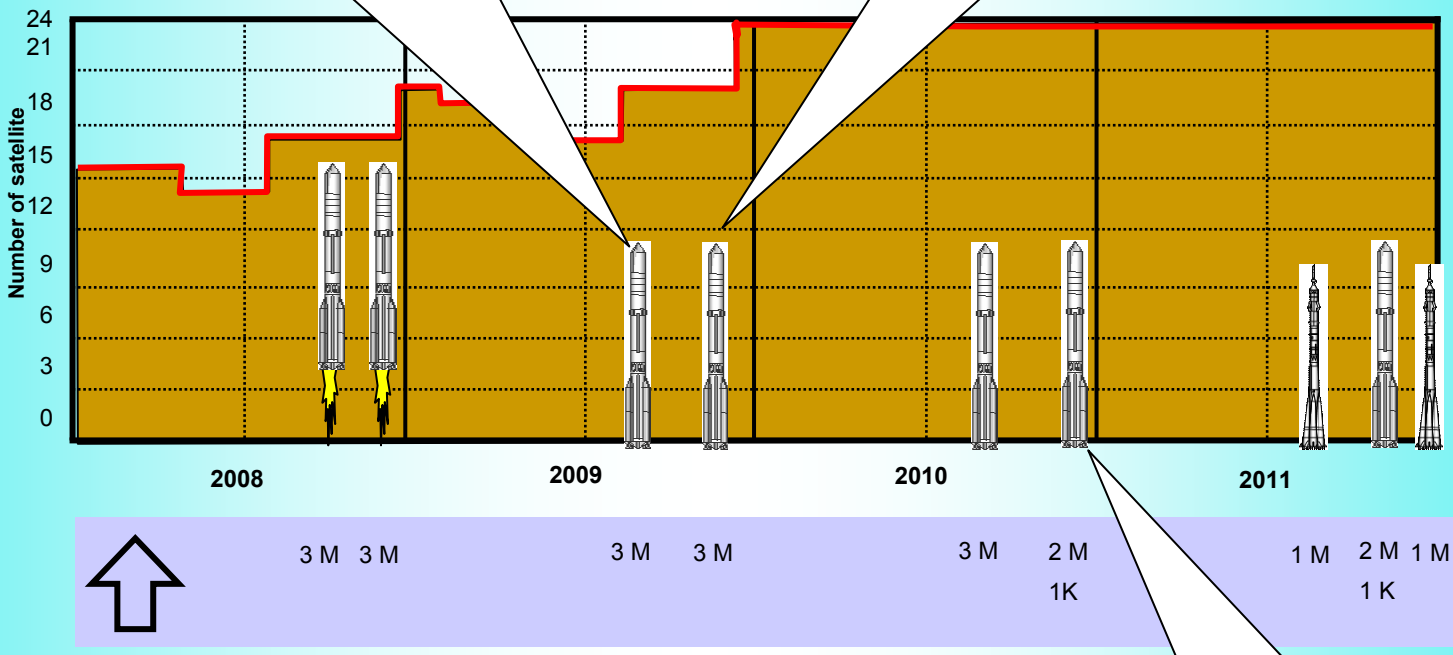
GLONASS constellation deployment program

POCKOCMOC

РЕШЕТНЕВ

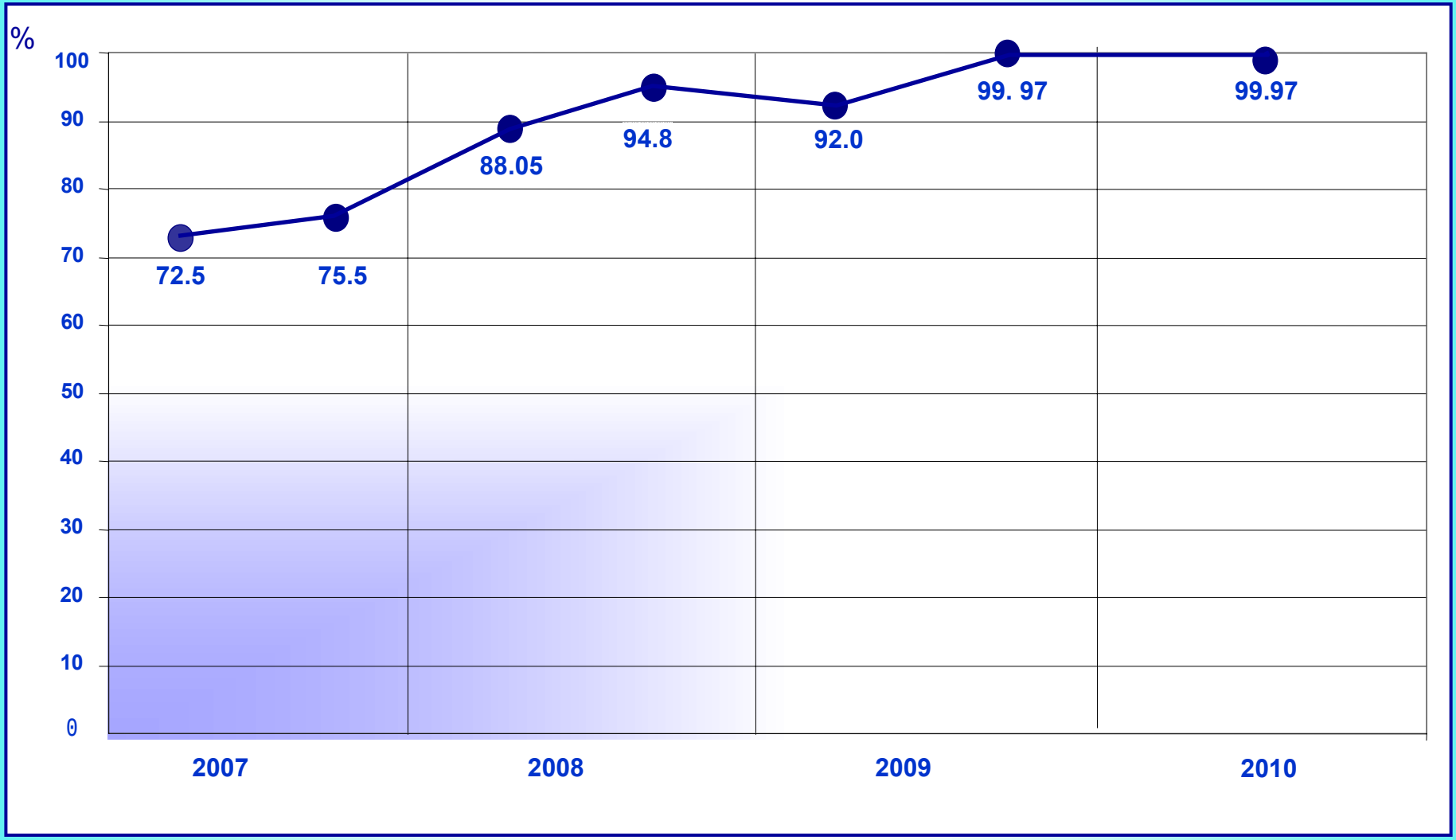
**September 2009 –
launch 3 “Glonass-M” sats**

**December 2009 –
Launch 3 “Glonass-M” sats**



First “Glonass-K” flight test model launch

Evolution of the GLONASS service global availability



Stage-by-stage GLONASS performance increasing

Accuracy (RMS)	Stage I (2008)	Stage II (2010)	Stage III (2012)
plane coordinates, m	6.2	3.5	1.4
speed, mm/s	14	10	7
time UTC(SU), ns	50	20	6
pseudorange, m	3,1	1,73	0,7

Stage 1. Maintenance of continuous navigation coverage for Russian Federation

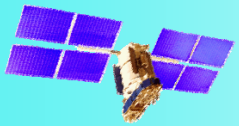
Stage 2. Maintenance of global continuous navigation coverage

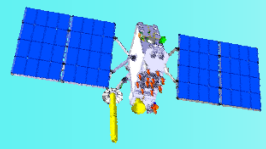
Stage 3. Improvement of basic GLONASS system performances

The direction of GLONASS navigation signals modernization

- Introduction of new CDMA signals
- Provide better potential accuracy for pseudorange and phase measurements
- Provide a better interference and multipath resistance of GLONASS signals
- Provide of greater interoperability with GPS and future GALILEO and other GNSS

The modernization concept of GLONASS navigation signals





	L1	L2	L3	Projected	Status
NavSat «Glonass»	L1OF L1SF	L2SF	-	-	Realized
NavSat «Glonass-M»	L1OF L1SF	L2OF L2SF	-	-	Realized
NavSat «Glonass-K»	L1OF L1SF	L2OF L2SF	L3OC	Open CDMA signals in L1, L2, L5 band	I - stage Will realized after 2010 Under discussions

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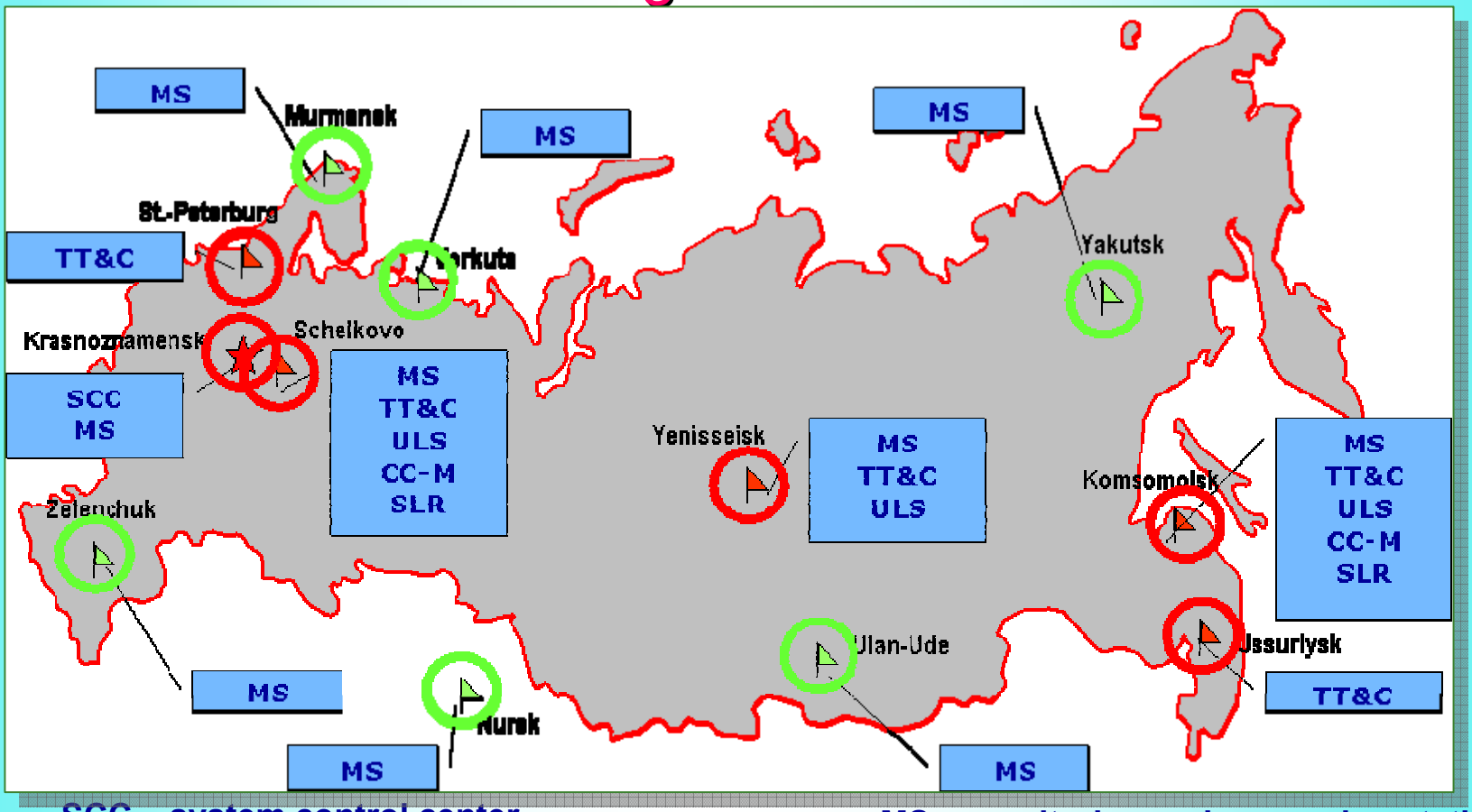
Modernization and development of GLONASS Ground Control Segment

- Extension of the monitoring and measuring stations network on national territories and expansion network abroad of the Russian Federation (Australia, Cuba, the South America)
- Development ephemeris and time corrections determination technologies based on the pseudorange and phase network measuring
- Hardware and software modernizations on the control centre and facilities of GLONASS Ground Segment
- Improvement of the Central System Clock stability and synchronization accuracy GLONASS time to UTC and GPS time
- Readjustment and calibration of measuring facilities of Ground Segment
- Further Refinement of GLONASS geodesy reference system (PZ-90.02) and improvement the transitions parameters to WGS84 and ITRF

Future view of GLONASS ground control segment



- SCC – system control center
- TT&C – telemetry, tracking, commanding station
- ULS – upload station
- New stations after 2010
- MS – monitoring and measuring station
- CC – central clock
- SLR – laser tracking station
- Operate stations

Summary

- The development and maintenance of GLONASS provides by special federal Program and takes up special focus in budget and policy of RF
- GLONASS accuracy and availability has significantly improved for last several years
- GLONASS Program is in progress and will be extended to 2020
- Current major GLONASS improvement objective are:
  - Deployment of full constellation (24 sats) by the end of 2010
  - Achieve the performances to be comparable or better then other GNSS by the end of 2011
  - Modernization navigations signals set, introduction new open CDMA signal on L3, and L1, L2 bands

Thank You for attention

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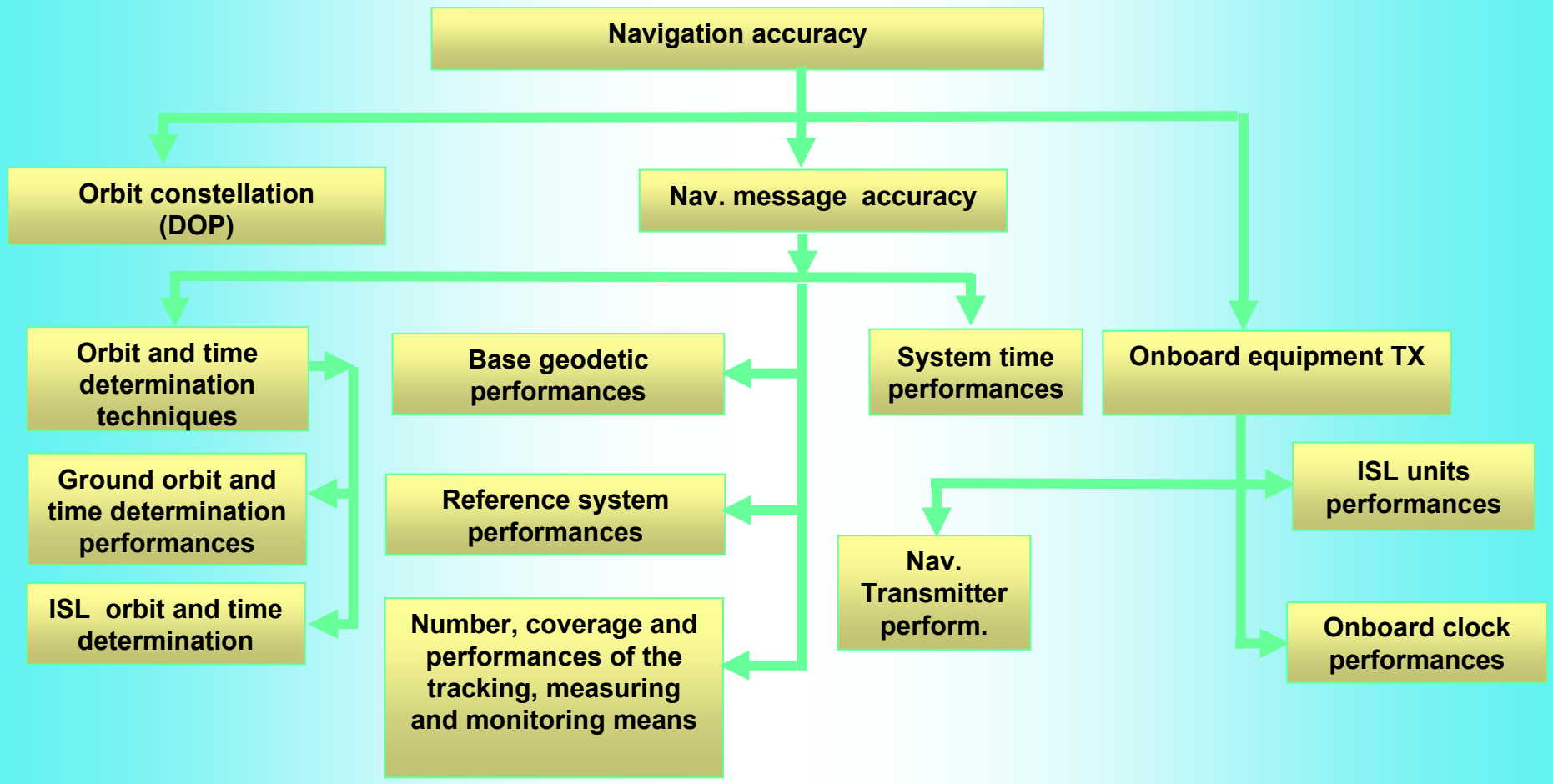
The factors taking into account in the GLONASS improvement programs



GLONASS positioning accuracy

(RMS value from 01.01.08 to 01.08.08 by real Glonass-M monitoring data and real constellation)